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DESCRIPTION

AUDIO SIGNAL CONTROLLER AND REPRODUCING DEVICE COMPRISING THE SAME

Field of the Invention

The present invention relates to a audio signal controller for controlling the quality of audio signals in audio visual equipment.

Background of the Invention

Conventional stereo audio equipment having visuals employs techniques for expanding sounds by providing a matrix surround circuit to make audience feel being at a live performance. FIG. 6 shows a stereo audio equipment comprising a matrix surround circuit 1. When a switch 2 is turned on, a controlling section 3 turns on a field effect transistor 4 and thus a sound effect. Reference numerals 5 and 6 denote a resistor for increasing and reducing the sound effect and a DC cutting capacitor. Amplifiers 7R, 8R, and 9R, and a speaker 10R in a right channel have as flat a frequency characteristic as possible, and amplifiers 7L, 8L, and 9L, and a speaker 10L in a left channel have as flat a frequency characteristic as possible.

Alternatively, a center speaker is sometimes used to add sounds near a band of human voices in order to make characters' speeches clearer. Alternatively, passband filters adapted for frequencies of a bass band and the band of human voices in audio signals are provided to control the volume of each band by using the result of the comparison of the outputs in order to provide effects depending on scenes in a movie source or the like.

Further, DVD (Digital Versatile Disc)-Videos with significantly improved storage capacities have started to

spread and many movie titles have been sold. Audio data recorded on the DVD with video data are sometimes compressed into, for example, a dolby digital (AC-3) 5.1-channel multichannel type, and to reproduce such data, six speakers including front speakers L and R, rear speakers L and R, a center speaker, a subwoofer speaker are typically used to enable videos and sounds to be simultaneously viewed and listened. In addition to the dolby-AC-3 audio data, dts (Digital Theater System) audio data recorded on the DVD are used as 5.1-channel mutichannel audio data and typically reproduced similarly to the dolby AC-3.

With the matrix surround circuit, however, when effect sounds are expanded while a movie with battle scenes is being viewed, the volume of speeches may diminish relatively to make them difficult to hear or sound images of speeches may be localized at deeper positions of corresponding video images.

Alternatively, in equipment with a center speaker, locations of sound images are biased to the center speaker and do not align with those of sources of sounds in corresponding video images, resulting in a sense of incongruity. For example, if a center speaker is installed on a cabinet of a television receiver, sound images are localized above corresponding video images and do not align therewith. Further, if such a center speaker is used, the center speaker and an amplifier for driving it are required.

Alternatively, equipment using a passband filter or a comparator requires a system for controlling this circuit, thereby increasing costs and complexity.

Moreover, sounds in a movie theater tends to have many harmonic components and do not have a sound quality suitable for reproducing music. Thus, disadvantageously, home compound equipment capable of reproducing both music and movies cannot reproduce the atmosphere in a movie theater.

Further, reproducing the dolby AC-3 or dts audio data requires the six speakers.

Disclosure of the Invention

It is an object of the present invention to provide an audio signal controller that uses a simple circuit configuration and two stereo speakers to produce sounds having clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater when the source is a stereo music, capable of localizing the speech at the center of the screen to align it with the corresponding image, and exhibiting as good a quality of sound as conventional when the sound is music.

It is another object of the present invention to provide a reproducing device operating even if a DVD having dolby AC-3 or dts multichannel audio data recorded thereon with video data is reproduced in such a manner that 5.1 channels are downmixed so that the data are output using two stereo speakers, to provide outputs similar to those with other data and determine the multichannel to automatically turn on a surround circuit and band-pass circuits.

To achieve these objects, an audio signal controller according to the present invention is a two-channel audio signal controller having a surround circuit, the controller being characterized by comprising the surround circuit capable of switching on and off a surround effect, band-pass circuits each interposed into a corresponding channel to switch between a band-pass on state where it provides such an output that a midrange of an audio signal frequency band has a higher gain than a bass and a treble ranges and a band-pass off state where a frequency characteristic is flat between the bass range and the treble range, and a controlling section for interlockingly switching on and off the surround circuit and the band-pass circuits.

According to the present invention, with the simple circuit configuration and the two speakers installed at corresponding sides of a TV monitor, an audio signal controller is obtained which is capable of producing sounds having clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater when the source is a stereo music, localizing the speech at the center of the screen to align it with the corresponding image, and exhibiting as good a quality of sound as conventional when the sound is music.

Alternatively, an audio signal controller according to the present invention is a two-channel audio signal controller having a surround circuit, the controller being characterized by comprising the surround circuit capable of switching on and off a surround effect, band-pass circuits each interposed into a corresponding channel to switch between a band-pass on state where it provides such an output that a midrange of an audio signal frequency band has a lower gain than a bass and a treble ranges and a band-pass off state where a frequency characteristic is flat between the bass range and the treble range, speakers each connected to an output of a corresponding one of the channels for executing electric-acoustic conversions and executing more efficient electric-acoustic conversions for a midrange than for the bass and treble ranges, and a controlling section for interlockingly switching on and off the surround circuit and the band-pass circuits.

Specifically, the present invention is characterized in that the midrange of the audio signal frequency band is set at a band between 400 Hz and 7 kHz.

Alternatively, a reproducing apparatus according to the present invention is a reproducing device having any of the above described audio signal controllers to reproduce audio data from a recording medium having the audio data recorded

thereon with video data, the reproducing device being characterized in that the reproducing device has means for reproducing audio data read from the recording medium and in that the controlling section interlockingly switches on and off the surround circuit and the band-pass circuits based on audio data read from the recording medium by the reproduction means.

Alternatively, the present invention is characterized in that the controlling section interlockingly switches on the surround circuit and the band-pass circuits if the audio data are determined to be sound-compressed multichannel data.

Alternatively, the present invention is characterized in that the multichannel audio data are dolby digital (AC-3) or dts audio data. Alternatively, a reproducing device according to the present invention is a reproducing device capable of reproducing as a recording medium, a DVD having at least video data and multichannel audio data recorded thereon, the reproducing device being characterized by comprising disc determining means for determining whether a disc used as a recording medium is a DVD or another disc, a decoder for extracting multichannel audio data from the recording medium and downmixing, before outputting, the data into two channels regardless of the number of channels in the original data, determining means for determining the type of the extracted multichannel audio data, a surround circuit capable of switching on and off a surround effect, band-pass circuits each interposed into a corresponding channel to switch between a band-pass on state where it provides such an output that a midrange of an audio signal frequency band has a higher gain than a bass and a treble ranges and a band-pass off state where a frequency characteristic is flat between the bass range and the treble range, and a controlling section for interlockingly switching on and off the surround circuit and band-pass circuits, the controlling section

interlockingly switching on the surround circuit and the band-pass circuits if it determines the audio data to be multichannel audio data.

Brief Description of the Drawings

FIG. 1 is a diagram showing the configuration of an (Embodiment 1) audio signal controller according to the present invention;

FIG. 2 is a frequency characteristic diagram of a band-pass circuit according to the embodiment;

FIG. 3 is a conceptual diagram of an acoustic frequency characteristic of a speaker outputs according to (Embodiment 2 of) the present invention;

FIG. 4 is a diagram showing the configuration of a reproducing device according to (Embodiment 3 of) the present invention;

FIG. 5 is a flowchart of a controlling section according to the embodiment; and

FIG. 6 is a diagram showing the configuration of conventional audio equipment comprising a surround circuit.

Best Mode for Carrying Out the Invention

Each embodiment of the present invention will be described below with reference to FIGS. 1 to 4.

Components acting in the same manner as those in FIG. 6 showing a conventional example are denoted by the same reference numerals.

(Embodiment 1)

FIG. 1 shows an audio signal controller according to (Embodiment 1 of) the present invention. Since a right channel and a left channel have the same configuration, the right channel will be explained by way of example.

A band-pass circuit 11R is provided before a matrix surround circuit 1. The band-pass circuit 11R comprises an

amplifier 7R to which are connected a first feedback circuit 12 comprising a resistor and a capacitor for cutting a treble range and a second feedback circuit 13 comprising a resistor and a capacitor for cutting a bass range. A band-pass characteristic is switched by turning on and off a transistor 14R.

FIG. 2 shows a frequency characteristic of the band-pass circuit 11R.

In a band-pass off state where the transistor 14R is turned off, the frequency characteristic is flat between the bass range and the treble range as shown by a solid line 15. In a band-pass on state where the transistor 14R is turned on, an output is such that a midrange around 1 kHz has a +5-dB higher gain than the bass and treble ranges as shown by a broken line 16.

Specifically, in the band-pass on state, the gain increases by 5 dB at 1 kHz compared to the frequency characteristic that is flat between the bass range and the treble range as observed in the band-pass off state, a bandwidth having the gain increased by 3 dB compared to the flat frequency characteristic in the band-pass off state has a lower limit frequency of 400 Hz and an upper limit frequency of 7 kHz, and a frequency characteristic of the band-pass circuit 11R is such that it provides such an output that the midrange between 400 Hz and 7 kHz has a higher gain than the bass and treble ranges, as shown in FIG. 2.

The transistor 14R is turned on and off by a controlling section 3 for turning on and off a surround effect.

The controlling section 3 is configured as described below.

If a normal music signal is reproduced, when a switch 2 is turned off, a field effect transistor 4 and thus a surround effect of the matrix surround circuit 1 and the transistor 14R are turned off and the band-pass circuit 11R exhibits the

flat frequency characteristic shown by the solid line 15. Thus, a music signal input to the amplifier 7R is flatly amplified between the bass range and the treble range and then subjected to an acoustic conversion in a speaker 10R with the frequency characteristic unchanged.

If a visual stereo signal from a movie source or the like is reproduced, when the switch 2 is turned on, the field effect transistor 4 and thus the surround effect of the matrix surround circuit 1 and the transistor 14R are turned on and the band-pass circuit 11R exhibits the frequency characteristic shown by the broken line 16 and that only the output midrange has a 5-dB higher gain. Consequently, the band-pass circuit 11R increases harmonic components in speeches and sounds of explosions or shots in battle scenes of movies to produce sounds with clear contours as heard in a movie theater. With the human sense of hearing, a listener sitting in front of the right and left speakers and between them hears the sounds as if their sound images are localized in front of the listener, so that a dynamic sound quality is obtained in the battle scenes. Contrary to the matrix surround circuit 1, which can provide the surround effect but doesn't localize speeches at deeper positions of the screen, this circuit carries out localization corresponding to images to extend sound fields for the listener, thereby producing dynamic sounds of explosions or helicopters.

Thus, according to this embodiment, the simple circuit configuration and the two speakers installed at corresponding sides of a TV monitor serve to produce sounds having clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater when the source is a stereo music, localize the speech at the center of the screen to align it with the corresponding image, and exhibit as good a quality of sound as conventional when the sound is music.

(Embodiment 2)

(Embodiment 2) is the same as (Embodiment 1) except that the speakers 10R and 10L have a frequency characteristic different from that of the band-pass circuits 11R and 11L.

The speakers 10R and 10L of (Embodiment 1) preferably provide a frequency characteristic that is as flat as possible between the bass region and the treble region. The speakers 10R and 10L according to (Embodiment 2) have such an acoustic frequency characteristic that the midrange around 1 kHz is subjected to a more efficient electric-acoustic conversion than the bass and treble regions, as shown by a broken line 17 in FIG. 3.

The band-pass circuits 11R and 11L have constants for the capacitors and resistors of the first and second feedback circuits 12 and 13 changed so that the midrange around 1 kHz is output with a lower gain than the bass and treble regions, as shown by a broken line 18 in FIG. 3.

With this configuration, to reproduce a normal music signal, the controlling section 3 turns on the transistor 14R while turning off the field effect transistor 4. Then, a music signal input to the amplifier 7R has its midrange output with a gain lower than those in the bass and treble regions, but since the speaker 10R has the acoustic frequency characteristic that the midrange is subjected to a more efficient acoustic conversion, the acoustic frequency from the speaker 10R has a synthetic frequency characteristic that is flat between the bass region and the treble region as shown by a solid line 19 in FIG. 3.

If a visual stereo signal from a movie source or the like is reproduced, when the switch 2 is turned on to allow the controlling section 3 to turn off the transistor 14R while turning on the field effect transistor 4, the music signal output from the speakers 10R and 10L exhibit a frequency characteristic that the output midrange has a 5-dB higher gain.

This configuration increases harmonic components in speeches and sounds of explosions or shots in battle scenes of movies to produce sounds with clear contours as heard in a movie theater. When hearing human voices, a listener sitting in front of the right and left speakers and between them hears the sounds as if their sound images are localized in front of the listener. In contrast, a dynamic sound quality is obtained in the battle scenes. Contrary to the matrix surround circuit 1, which can provide the surround effect but doesn't localize speeches at deeper positions of the screen, this circuit carries out localization corresponding to images to extend sound fields for the listener, thereby producing dynamic sounds of explosions or helicopters.

As described above, the simple circuit configuration and the two speakers installed at corresponding sides of a TV monitor serve to produce sounds having clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater when the source is a stereo music, localize the speech at the center of the screen to align it with the corresponding image, and exhibit as good a quality of sound as conventional when the sound is music.

(Embodiment 3)

FIGS. 4 and 5 show (Embodiment 3).

FIG. 4 shows a recording and reproducing device having the audio signal controller according to (Embodiment 1). In (Embodiment 1), the switch 2 is manually operated, but (Embodiment 3) requires no such manual operation.

The same components as in (Embodiment 1) are denoted by the same reference numerals for explanation.

The recording and reproducing device shown in FIG. 4 can reproduce an optical disk 20 such as a DVD, a VIDEO-CD (hereafter referred to as a "VCD"), or a CD-DA which acs as a recording medium. The VCD and the CD-DA conform to a CD

standard including a common physical structure and are collectively referred to as "CDs" for explanation.

The optical disc 20, which is being rotatively driven by a spindle motor 21, has its recording surface irradiated with light via an objective incorporated in an optical pickup 22. Light reflected from the recording surface is then detected to read information data recorded on the optical disc 20.

The detected signal from the optical pickup 22 is amplified by an RF amplifier 23, and combined-use servo and disc determining means 24 determines from an output signal from the RF amplifier 23 whether the optical disc 20 is a DVD or a CD to carry out controls including focus control of the optical pickup 22, tracking servo, and spindle servo of the spindle motor 21.

Reference numeral 25 denotes a decoder having a video decoder (not shown) and an audio decoder 26. If audio data input by the RF amplifier 23 are of a multichannel type, the audio decoder 26 downmixes the data and outputs them as two-channel stereo signals L and R.

If the decoder 25 has determined the disc to be a DVD, the type of the audio data recorded with video data is determined by loading the data input to the audio decoder 26 in a controlling section 27 and determining an identification code for control information recorded in the DVD, based on the loaded information. That is, the types of sound compression recording methods for MPEG2 audio data, dolby AC-3 audio data, and dts audio data are determined.

The data through the channels L and R, which have been output after being downmixed into the two channels by the audio decoder 26, are input to the band-pass circuits 11R and 11L.

The band-pass circuits 11R and 11L each switch between a band-pass on state where it provides such an output that a midrange of an audio signal frequency band has a higher gain

than a bass and a treble ranges, compared to an output from the audio decoder 26 and a band-pass off state where it outputs a frequency characteristic that is flat between the bass range and the treble range.

An output from each of the band-pass circuits 11R and 11L is input to the matrix surround circuit 1. The matrix surround circuit 1 is configured to switch between an on state where the output from each of the band-pass circuits 11R and 11L is output after being subjected to a surround effect and an off state where the output from each of the band-pass circuits 11R and 11L is output without being subjected to the surround effect.

The output from the band-pass circuit 11R via the matrix sound circuit 1 is reproduced by the speaker 10R via the amplifier 9R, while the output from the band-pass circuit 11L via the matrix sound circuit 1 is reproduced by the speaker 10L via the amplifier 9L.

The controlling section 27 controls the combined-use servo and disc determining means 24 by collecting information on the result of the disc determination and controlling reproduction of the optical disc 20, and controls the decoder 25 by determining, as described above, the identification code for the control information recorded in the DVD based on the loaded information, to determine the type of the audio data, setting an audio data decoding method based on the determination of the recording method, setting the band-pass circuits 11R and 11L and the matrix surround circuit 1 on or off based on the control described below, and displaying the on and off states on a display section 28. The controlling section 27 is also configured to collect information on depressing of an on and off switches (not shown) of an operation section 29 to switch the band-pass circuits 11R and 11L and the matrix surround circuit 1.

When the optical disc 20 is set, the combined-use servo and disc determining means 24 causes the spindle motor 21 to rotate the optical disc 20, causes the optical pickup 22 to irradiate the optical disc 20 with light through an objective incorporated in the optical pickup 22 to detect light reflected from the recording surface, determines from an output amplified by the RF amplifier 23 whether the optical disc 20 is a DVD or a CD, and outputs a result of the determination to the controlling section 27.

The output from the RF amplifier 23 is input to the decoder 25, and if the optical disc 20 is a DVD, the input data are loaded in the controlling section 27 via the audio decoder 26, and the controlling section 27 determines the identification code for the control information recorded in the DVD based on the loaded information, to determine the type of the recording method. Based on the result of the determination of the recording method, the controlling section 27 sets a decode method in the audio decoder 26. The audio decoder 26, for which the decode method has been set by the controlling section 27, downmixes the output from the RF amplifier 23 if it is multichannel dada, thereby decoding it into a two-channel stereo audio signal.

The output from the audio decoder 26 is input to each of the band-pass circuits 11R and 11L, which provides such an output that the midrange of the audio signal frequency band has a higher gain than the bass and treble ranges, compared to the output from the audio decoder 26, if the output from the audio decoder 26 has been set on by the control provided by the controlling section 27, which will be described later. If the output from the audio decoder 26 has been set off, the band-pass circuits 11R and 11L each outputs a frequency characteristic that is flat between the bass range and treble range of the audio signal frequency band, compared to the output from the audio decoder 26. The output from each of

the band-pass circuits 11R and 11L is input to the matrix surround circuit 1, where the input data are output after undergoing the surround effect if it has been set on by the control provided by the controlling section 27, which will be described below. If it has been set off, the data are output without undergoing the surround effect, compared to the output from the band-pass circuit 11R or 11L.

FIG. 5 shows a process routine that is executed by the controlling section 27 to control the band-pass circuits 11R and 11L and the matrix surround circuit 1.

At step S101, the controlling section 27 determines whether the optical disc 20 is a DVD, from the information on the determination of the optical disc obtained from the combined-use servo and disc determining means 24. If the optical disc 20 is a CD, the controlling section 27 executes a routine between steps S102 and 104.

At step S102, the band-pass circuits 11R and 11L and the matrix surround circuit 1 are turned off. At step S103, the display section 28 displays the off state. At step S104, it is detected whether the on switch of the operation section 29 has been operated, and if not, steps S102 and S103 are repeated. If it is detected at step S104 that the on switch of the operation section 29 has been operated, a routine between steps S105 and S107 is executed.

At step S105, the band-pass circuits 11R and 11L and the matrix surround circuit 1 are turned on. At step S106, the display section 28 displays the on state. At step S107, it is detected whether the off switch of the operation section 29 has been operated, and if not, steps S105 and S106 are repeated. If it is detected at step S107 that the off switch of the operation section 29 has been operated, the process returns to step S102.

On the other hand, if it is determined at step S101 that the disc is a DVD, it is determined at step S108 whether the

recording method is the AC-3, from a stream ID analyzed by the decoder 25.

If it is determined at step S108 that the recording method for the optical disc 20 is the AC-3, the routine between steps S105 and S107 is executed to automatically turn on the band-pass circuits 11R and 11L and the matrix surround circuit 1.

If it is determined at step S108 that the recording method for the optical disc 20 is not the AC-3, it is determined at step S109 whether the recording method is the dts, from the stream ID analyzed by the recording method determining section 25 at step S109.

If it is determined at step S109 that the recording method for the optical disc 20 is the dts, the routine between steps S105 and S107 is executed to automatically turn on the band-pass circuits 11R and 11L and the matrix surround circuit 1.

If it is determined at step S109 that the recording method for the optical disc 20 is not the dts, the routine between steps S102 and S104 is executed to automatically turn off the band-pass circuits 11R and 11L and the matrix surround circuit 1.

With this configuration, if it is determined that the disc 20 is a DVD and that the audio data have been recorded based on the AC-3 or the dts, the band-pass circuits 11R and 11L and the matrix surround circuit 1 are turned on and the display section 28 shows "ON", thereby producing sounds with clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater, despite the acoustic outputs from the two-channel speakers.

Alternatively, if the disc 20 is a CD-DA, a VCD, or a DVD and the recording method is the MPEG2, the display section 28 shows "OFF" and the matrix surround circuit 1 and the band-pass circuits 11R and 11L are turned off, thereby

enabling the sound information recorded in the optical disc 20 to be reproduced with as good a sound quality as conventional.

In addition, if the user desires to change settings based on the "ON" or "OFF" shown on the display section 28, the user can depress the ON or OFF switch of the operation section 29 to arbitrarily change the settings for the matrix surround circuit 1 and the band-pass circuits 11R and 11L.

As described above, according to the present invention, the surround circuit and the band-pass circuits are provided in parallel for each channel and the controlling section interlockingly switches on and off the characteristics of these circuits, so that with the simple circuit configuration and the two speakers installed at corresponding sides of a TV monitor, an audio signal controller for a two-channel stereo is obtained which is capable of producing sounds having clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater when the source is a stereo music, localizing the speech at the center of the screen to align it with the corresponding image, and exhibiting as good a quality of sound as conventional when the sound is music.

Additionally, if it is determined that the audio data recorded on the recording medium are of the dolby AC-3 or dts multichannel type, the surround circuit and the band-pass circuits are automatically turned on, thereby realizing a reproducing device that produces, without any operations, sounds with clear contours and a sound effect imparting a sound expanse feeling as obtained in a movie theater, despite the acoustic outputs from the two-channel speakers.

Additionally, if it is recorded as multichannel audio data, the surround circuit and the band-pass circuits are automatically turned off, thereby obtaining audio record

information of as good a quality of sound as conventional when the audio record information is reproduced.